

Pollution in Fish - Bioaccumulation

Grades

Any

Subjects

Science, Health, Biology, Ecology and Math

Type of Lesson Plan

Activity

Duration

20 minutes

Materials

- Napkins or sheets of paper

Objective

TLW...

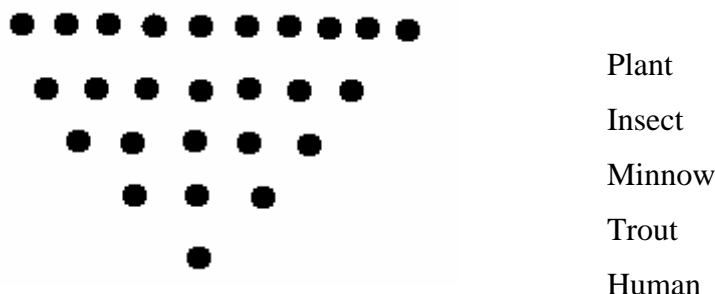
- Learn how toxins can bioaccumulate through the food chain.
- Understand the bioaccumulation of toxins in food can harm humans that consume the contaminated food.

Set

Introduce, or review the concept of the food chain/web.

Instructional Input

You will be using the class to actively demonstrate the mechanics of the food chain as well as the mechanics and effects of bioaccumulation.



Arrange the students in the above formation. The formation is based on a class of 26. Adjust the formation to suit your class size.

Place a sheet of paper or napkin in the hands of each student in the front row (“plants”). Instruct the students in the row behind (“insects”) to take the paper from the students in front of them and place in their own hands. This represents insects feeding on plants. Next, have the “minnows” feed on the “insects”, and then the “trout” should feed on the “minnows.” The human should feed on all of the trout, and should have accumulated all of the napkins. *This can be done with pennies and cups with younger kids. The kids can then decorate their cup as what they are (plant or trout). With older kids, colored pieces of paper with each color representing plants, insects, etc. will work. The plants or insects that are contaminated can have a black “X” placed on the back. The students can then see the build-up in chemicals only at certain levels because everything would not be contaminated. Fact sheet should only be used at the secondary level.*

Next, explain that the sheets of paper or napkins represent pollutants called dioxins. The dioxins made their way from a nearby source (a pulp and paper mill, waste and drinking water treatment plant, organic chemical manufacturer, municipal solid waste and industrial incinerator) into the sediment of the stream in which the plants live. The dioxins entered the plants from the sediment. When the insects ate the dioxin contaminated plants, the dioxin entered and stayed in their bodies. When the minnows ate the insects, they also accumulated the dioxins present in the insects. When the trout ate the minnows, the dioxins concentrated in the minnows were transferred to the trout. When the trout were consumed by the human, the entire load of dioxins from all the plants that served as the food for the insects, which fed the minnows, which fed the trout were transferred to the humans.

This phenomenon is called bioaccumulation. If each plant contained only one unit of dioxin, then the amount of dioxin that the human ingested was 10 units (1 unit for each of the primary producers that were consumed by all the organisms below the human on the food chain). Point out that even small amounts of pollution in the environment can be concentrated into amounts that are harmful to humans due to bioaccumulation.

Resources

Agency for Toxic Substances and Disease Registry (ATSDR) public health statement fact sheet for Dioxins which can be obtained at <http://www.atsdr.cdc.gov/tfacts104.pdf>.

Closure

Using the ATSDR fact sheet on dioxins, point out the sources of dioxin pollution as well as the human health effects of dioxins to the class.

This fact sheet answers the most frequently asked health questions (FAQs) about chlorinated dibenzo-p-dioxins (CDDs). For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to chlorinated dibenzo-p-dioxins (CDDs) (75 chemicals) occurs mainly from eating food that contains the chemicals. One chemical in this group, 2,3,7,8-tetrachlorodibenzo-p-dioxin or 2,3,7,8-TCDD, has been shown to be very toxic in animal studies. It causes effects on the skin and may cause cancer in people. This chemical has been found in at least 91 of 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are CDDs?

CDDs are a family of 75 chemically related compounds commonly known as chlorinated dioxins. One of these compounds is called 2,3,7,8-TCDD. It is one of the most toxic of the CDDs and is the one most studied.

In the pure form, CDDs are crystals or colorless solids. CDDs enter the environment as mixtures containing a number of individual components. 2,3,7,8-TCDD is odorless and the odors of the other CDDs are not known.

CDDs are not intentionally manufactured by industry except for research purposes. They (mainly 2,3,7,8-TCDD) may be formed during the chlorine bleaching process at pulp and paper mills. CDDs are also formed during chlorination by waste and drinking water treatment plants. They can occur as contaminants in the manufacture of certain organic chemicals. CDDs are released into the air in emissions from municipal solid waste and industrial incinerators.

What happens to CDDs when they enter the environment?

- ☐ When released into the air, some CDDs may be transported long distances, even around the globe.

- ☐ When released in waste waters, some CDDs are broken down by sunlight, some evaporate to air, but most attach to soil and settle to the bottom sediment in water.
- ☐ CDD concentrations may build up in the food chain, resulting in measurable levels in animals.

How might I be exposed to CDDs?

- ☐ Eating food, primarily meat, dairy products, and fish, makes up more than 90% of the intake of CDDs for the general population.
- ☐ Breathing low levels in air and drinking low levels in water.
- ☐ Skin contact with certain pesticides and herbicides.
- ☐ Living near an uncontrolled hazardous waste site containing CDDs or incinerators releasing CDDs.
- ☐ Working in industries involved in producing certain pesticides containing CDDs as impurities, working at paper and pulp mills, or operating incinerators.

How can CDDs affect my health?

The most noted health effect in people exposed to large amounts of 2,3,7,8-TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, dis-

ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html>

coloration, and excessive body hair. Changes in blood and urine that may indicate liver damage also are seen in people. Exposure to high concentrations of CDDs may induce long-term alterations in glucose metabolism and subtle changes in hormonal levels.

In certain animal species, 2,3,7,8-TCDD is especially harmful and can cause death after a single exposure. Exposure to lower levels can cause a variety of effects in animals, such as weight loss, liver damage, and disruption of the endocrine system. In many species of animals, 2,3,7,8-TCDD weakens the immune system and causes a decrease in the system's ability to fight bacteria and viruses. In other animal studies, exposure to 2,3,7,8-TCDD has caused reproductive damage and birth defects. Some animal species exposed to CDDs during pregnancy had miscarriages and the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy often had severe birth defects including skeletal deformities, kidney defects, and weakened immune responses.

How likely are CDDs to cause cancer?

Several studies suggest that exposure to 2,3,7,8-TCDD increases the risk of several types of cancer in people. Animal studies have also shown an increased risk of cancer from exposure to 2,3,7,8-TCDD.

The World Health Organization (WHO) has determined that 2,3,7,8-TCDD is a human carcinogen.

The Department of Health and Human Services (DHHS) has determined that 2,3,7,8-TCDD may reasonably be anticipated to cause cancer.

How can CDDs affect children?

Very few studies have looked at the effects of CDDs on children. Chloracne has been seen in children exposed to high levels of CDDs. We don't know if CDDs affect the ability of people to have children or if it causes birth defects, but given the effects observed in animal studies, this cannot be ruled out.

How can families reduce the risk of exposure to CDDs?

- ☐ Children should avoid playing in soils near uncontrolled hazardous waste sites.
- ☐ Discourage children from eating dirt or putting toys or other objects in their mouths.
- ☐ Everyone should wash hands frequently if playing or working near uncontrolled hazardous waste sites.
- ☐ For new mothers and young children, restrict eating foods from the proximity of uncontrolled sites with known CDDs.

Is there a medical test to show whether I've been exposed to CDDs?

Tests are available to measure CDD levels in body fat, blood, and breast milk, but these tests are not routinely available. Most people have low levels of CDDs in their body fat and blood, and levels considerably above these levels indicate past exposure to above-normal levels of 2,3,7,8-TCDD. Although CDDs stay in body fat for a long time, tests cannot be used to determine when exposure occurred.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.00003 micrograms of 2,3,7,8-TCDD per liter of drinking water (0.00003 µg/L). Discharges, spills, or accidental releases of 1 pound or more of 2,3,7,8-TCDD must be reported to EPA. The Food and Drug Administration (FDA) recommends against eating fish and shellfish with levels of 2,3,7,8-TCDD greater than 50 parts per trillion (50 ppt).

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1998. Toxicological profile for chlorinated dibenzo-p-dioxins. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop E-29, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 404-498-0093. ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html> ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

